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# TACTOOL: SONOBUOY TACTICAL DEVELOPMENT TOOL- USERS GUIDE VERSION 2.1

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# TacTool: Sonobuoy Tactical Development Tool User's Guide Version 2.1


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## Abstract

The TacTool sonobuoy tactical development tool has been developed to assist tactical development officers to plan and work with multistatic sonobuoy scenarios. The tool allows the specification of multistatic sonobuoy patterns and the analysis of the pattern detection performance in terms of coverage and cumulative probability of detection. The tool uses a Monte Carlo simulation engine to calculate performance measures. This document provides the user with a guide to TacTool version 2.1's features, and the format of certain critical input files.



## Résumé

L'outil de développement tactique de bouée acoustique TacTool a été mis au point pour aider les officiers chargés du développement tactique à planifier et à utilser des scénarios relatifs à des bouées acoustiques multistatiques. L'outil permet de spécifier des configurations de bouée acoustique multistatique et d'analyser les performances de détection de configuration, du point de vue de la couverture et de la probabilité cumulative de détection. L'outil repose sur un moteur de simulation Monte Carlo pour calculer les mesures de performance. Ce document fournit à l'utilisateur un guide sur les caractéristiques de TacTool, version 2.1, et sur le format de certains fichiers d'entrée essentials.

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# 1.0 Introduction

The TacTool application is a tactical development tool created to assist Maritime Air ASW tacticians in the development of sonobuoy deployment tactics. The tool allows the specification of sonobuoy deployment patterns within the TacPlot window, control of environmental, target, and system parameters through menu driven entry screens, and pattern detection capability assessment using a Monte-Carlo simulation engine. Simulation results are displayed spatially in the TacPlot window and temporally in the SimPlot window.

This guide describes the components of the TacTool application and their purposes. These components include various menus, toolbars, status bars, views and dialogs. Also included are the formats for the various input files with examples.

This guide describes some capabilities, which are not included in this version of TacTool. Such capabilities may be included at a later date. Sections within the guide that pertain to capabilities not included in this version of TacTool are denoted by *italicised* text.

## 1.1 TacTool Usage

To use TacTool to examine a particular sonobuoy distribution the following steps are required:

1. Start TacTool by double clicking on the TacTool icon

2. Click on "**Simulation | Environment**". Find the environment (*.env) file that contains the environment of interest and load it. If a new environment is required, then the individual transmission loss and reverberation files must be generated using acoustic models and the environment file created using the format in Section 7.1.

3. Click on "**Simulation | Threat Type | Load...**". Find the threat type (*.tht) file containing the threat of interest and load it. Once loaded, the properties of the threat type can be edited by clicking on "**Simulation | Threat Type | Edit...**" and changing the appropriate parameters. If no *.tht file exists for the threat of interest, then one can be created from within TacTool.

4. Click on "**Simulation | Threat Profile | Load...**". Find the threat operating profile (*.thp) file containing the operation profile of interest and load it. Once loaded, the properties of the threat operating profile can be edited by clicking on "**Simulation | Threat Profile | Edit...**" and changing the appropriate parameters. If no *.thp file exists for the threat of interest, then one can be created from within TacTool.

5. Click on "**Simulation | Sonobuoy Types**". From there click on either "**New**" to create a new sonobuoy type or on "**Load**" to load a set of sonobuoy types from a sonobuoy type (*.sbt) file. Ensure that there is at least one type of sonobuoy that has a transmitter, and at least one type of receiver with a bandwidth that overlaps the transmitter centre frequency.

6. Using either the "**Deploy**" menu or right clicking in the TacPlot window, deploy sonobuoys as required. At least one deployed sonobuoy must have a transmitter. Note that receiver sonobuoys are drawn in the TacPlot window as circles with an upward barb, while transmitter sonobuoys are drawn as double circles with an upward barb.

7. Click on "**Simulation | Ping Schedule**". Schedule at least one ping using the dialog box.

8. Click on **"Simulation | Run"**. A run time status window will display the percentage of Monte-Carlo simulation runs completed, the time elapsed in the run, and the estimated time required to complete the run. If the **Cancel** button is pressed statistics will be displayed based on the number of runs completed to that point.

9. Simulation results can be viewed either by displaying a SimPlot window from the **Window** menu, or by selecting the desired **"TacPlot | Results"** menu item. Some TacPlot results require manipulation of some **"TacPlot | Options"** menu items.

For more detailed instructions on using TacTool please refer to the sections below.

## 2.0 TacTool Main Menubar

### 2.1 File Menu

The "File" menu is composed of nine basic menu items and a dynamic list of recently used files. The nine menu items are described below.

**New** - Creates a new empty simulation (.sts) file, which can be saved to disk with the "Save" menu item.

**Open...** - Allows the user to select a previously saved simulation (.sts) file to be loaded from disk.

**Close** - Allows the user to close the currently active simulation. If the simulation has been changed, but not saved, the user will be prompted to save or discard the changes.

**Save** - Allows the user to save the currently open and active simulation (.sts) file.

**Save As...** - Allows the user to select a new location and/or name to use to save the currently open simulation (.sts) file.

**Print...** - Prints the current TacPlot using the current map scale and view settings.

**Print Preview** - Displays the current TacPlot, as it would be printed using the current map scale and view settings.

**Print Setup...** - Allows the user to select the printer to print to, the paper size and the page orientation.

**Exit** - Allows the user to terminate the TacTool application. If the currently open simulation file has been modified and not saved, then the user will be prompted as to what action should be taken before terminating.

### 2.2 Edit Menu

The "Edit" menu is composed of four menu items that allow interaction between the Windows clipboard and the deployment annotations area, which is located under the Deployment Tree View.

**Undo** - Allows the user to revert a previous Edit/Cut or Edit/Paste operation.

**Cut** - Allows the user to remove selected text from the deployment annotation area and store it in the windows clipboard.

**Copy** - Allows the user to store a copy of text selected in the deployment annotation area in the Windows clipboard.

**Paste** - Allows the user to place a copy of the contents of the Windows clipboard in the deployment annotation area at the current cursor location.

## 2.3 View Menu

The "View" menu is composed of two menu items that refer to the two application-window view options described below.

**Toolbar** - Allows the user to toggle display of the TacTool toolbar (Section 4.0) on and off.

**Status Bar** - Allows the user to toggle display of the TacTool status bar (Section 5.0) on and off.

## 2.4 TacPlot Menu

The "TacPlot" menu, which is only available when the TacPlot map view (Section 3.1) is the active view, is broken into four sections. The first section is composed of two submenus that control the display of spatial results and the scale of the TacPlot. The second section contains toggles for various TacPlot overlay items. This section's menu items are toggled, and a check mark to the left of the items' descriptions indicates that the option is on or enabled. The third section contains an item for accessing TacPlot options. The fourth section allows the current graphic to be exported.

**Results** - This submenu allows the user to select between, and turn off, the display of any of the available spatial simulation results on the TacPlot. The currently active menu selection is indicated by a bullet to the left of the menu item. The current options are "None", "Coverage", "Detection", and "Receiver Contact". See Section 3.1 for descriptions of the different types of spatial results.

**Scale** - This submenu allows the user to select a map scale for the TacPlot (Section 3.1) from a list of six possible scales.

**Labels** - Allows the user to toggle display of sonobuoy identification labels on the TacPlot (Section 3.1) on and off.

**Grid Lines** - Allows the user to toggle display of grid lines and grid labels on the TacPlot (Section 3.1) on and off.

**Level Legend** - Allows the user to toggle display of the colour level scale on the TacPlot (Section 3.1) on and off. When on, the legend is displayed as a vertical bar in the upper left corner of the TacPlot map view.

**Options** - Allows the adjustment of the colour scales used to display results. For more information see Section 6.6.

**Export Plot** - Allows the user to save the current TacPlot map view contents as a Windows bitmap (.bmp) format file.

## 2.5 Sonobuoy Menu

*The "Sonobuoy" menu has not been included in the current version of TacTool, and may be included in a later release. The capabilities included in this menu are found in the current version of TacTool in the dialog box obtained by clicking on "Simulation | Sonobuoy Types". The "Sonobuoy" menu will be comprised of six items, which control the sonobuoy types available during a simulation.*

***New*** - *Allows the user to specify a new sonobuoy type that will be available to a subsequent deployment and simulation.*

***Edit*** - *Allows the user to modify available sonobuoy types by selecting one from a list of current types and editing the sonobuoy specifications.*

***Delete*** - *Allows the user to delete a sonobuoy type from the current session.*

***Load*** - *Allows the user to load a file containing sonobuoy types into the current session.*

***Save*** - *Allows the user to save the current list of sonobuoy types to a file on disk.*

***Close*** - *Closes the "Available Sonobuoy Types" dialog box.*

## 2.6 SimPlot Menu

The **"SimPlot"** menu is only available when the SimPlot graph view (Section 3.3) is the active view, and is composed of two items. These items are:

**PD Results** - This is a submenu that allows the user to select between, and turn off, the display of any of the available temporal simulation results on the SimPlot. The currently active menu selection is indicated by a bullet to the left of the menu item, and the current options are "None", "Instantaneous", "Cumulative", and "All".

**Options** - This invokes the SimPlot options dialog described in Section 6.7 of this users' guide.

## 2.7 Deploy Menu

The **"Deploy"** menu allows the user to add single sonobuoys and patterns of sonobuoys to the current open and active simulation file. Aside from the main menubar, this particular menu can be accessed as a context (right mouse button) menu from the TacPlot map view described in Section 3.1 of this users' guide. All of the items in this menu perform essentially the same task: they all invoke the "Deploy" property sheet dialog for the indicated deployment type. If the property sheet is closed with the **OK** button, the new deployment is added to the collection of deployments in the currently open and active simulation file. The property sheet dialogs are described in Section 6.0 of this guide.

## 2.8 Simulation Menu

The "**Simulation**" menu is composed of menu items that deal with the setup and running of a simulation scenario. They are described below.

**Environment** - Allows the user to select (load) an acoustic environment (.env) data file from disk. The currently loaded environment is indicated in parentheses next to the menu item's text. Environment files must be created prior to running TacTool. TacTool has no environmental modelling capability. All transmission loss, reverberation, and ambient noise data must be obtained from other sources for input to TacTool. Section 7.1 has a description of the format of the (.env) files and a sample .env file.

**Threat Type** - This has three submenu options: "**Load...**", "**Edit...**", and "**Save...**". The first invokes the "Load Threat Type" dialog box, which allows the user to select the desired threat type (.tht) file. The second option opens the "Threat Type Properties" dialog box in order to edit the properties of the threat. The third option opens the "Save Threat Type As" dialog box and allows the user to choose a filename under which to save the parameters of the current threat type.

**Threat Profile** - This has three submenu options: "**Load...**", "**Edit...**", and "**Save...**". The first invokes the "Load Threat Operating Profile" dialog box, which allows the user to select the desired threat operating profile (.thp) file. The second option opens the "Threat Operating Profile" dialog box in order to edit the parameters under which the threat is operating. The third option opens the "Save Threat Operating Profile As" dialog box and allows the user to choose a filename under which to save the parameters of the current threat profile.

**Sonobuoy Types** - Invokes the "Available Sonobuoy Types" dialog described in Section 6.4 of this users' guide. If at least one sonobuoy type has been defined then a check mark will be present to the left of the menu item's text. *Note that this menu item may be removed in later versions of TacTool.*

**Ping Schedule** - Invokes the "Ping Schedule" dialog described in Section 6.8 of this users' guide. This option is only enabled if an environment has been loaded, and at least one deployment has been defined.

**Options** - Invokes the "Simulation Options" property sheet dialog described in Section 6.9 of this users' guide. These are the simulation engine controls, such as number of Monte Carlo runs to be done and the maximum time scale of the simulation.

**Export Transmitters** - Invokes the "Export Deployed Transmitters" dialog box, which allows the user to save transmitter specifications to a file (.xmt) for future use.

**Import Transmitters** - Invokes the "Import Transmitters" dialog box, which allows the user to load previously saved transmitter specifications from a file (.xmt) for use within the current session.

**Run** - Causes the simulation to run using the current settings. This option is only enabled if an environment and threat have been loaded, and at **least** one deployment (Sections 2.7 and 6.1) and at **least** one sonobuoy type (Sections 6.4 and 6.5) have been defined.

## 2.9 Window Menu

The "**Window**" menu is available whenever there is at least one simulation window. It is composed of three sections. The first section provides menu items for opening additional windows associated with the currently active simulation. The second section provides menu items for manipulating the open simulation windows contained in the main TacTool application window. The last section is composed of a list of all available simulation windows. Selecting from the list opens and activates the selected simulation window. The currently active window is check-marked in the list.

**New TacPlot Window** - Opens a new TacPlot window associated with the currently active simulation. Note that modifications made to the simulation in this view will also appear in the other views associated with that simulation.

**New SimPlot Window** - Opens a new SimPlot window associated with the currently active simulation.

**Cascade** - Cascades all open simulation windows diagonally downward and to the right, starting from the top left corner of the main TacTool application window.

**Tile** - Tiles the main TacTool application window with all open simulation windows.

**Arrange Icons** - Arranges all iconized simulation windows into rows across the bottom of the main TacTool application window.

## 2.10 Help Menu

The "**Help**" menu contains only one item, the "**About TacTool**" item. That menu item displays the TacTool application's "About TacTool" dialog box, which contains version and copyright information about the TacTool application.

## 3.0 TacTool Windows and Views

The TacTool application's main window can contain an indefinite number of the various types of simulation windows. Initially TacTool displays one TacPlot window for an open simulation. This window is composed of three panes, one to the right and two on the left, one over the other. The upper left-hand pane contains a deployment tree view of the simulation and the lower left-hand pane is an area for deployment annotations. The right-hand pane contains a TacPlot map view of the simulation and results.

By using the **"Window"** menu (Section 2.9) it is also possible to open a single paned SimPlot window. The pane of the SimPlot window contains a SimPlot graph view of the simulation results.

The purpose of these views is to allow the user to quickly and easily devise sonobuoy deployment schemes, and to compare and evaluate the performance of these schemes. Note that any changes made to a simulation in one view will be immediately apparent in all other views associated with that simulation as appropriate. The TacPlot map view, deployment tree view, and SimPlot graph view are discussed in the following sections.

### 3.1 TacPlot Map View

The larger pane on the right-hand side of the TacPlot simulation window is the TacPlot map view. Its purpose is to provide the user with visual information about the relative positions of the deployed sonobuoys. It is also used to display spatial detection statistics obtained from a simulation run. The **"TacPlot"** menu contains items that pertain directly to the map. These include the simulation results display submenu, the map scale selection submenu, the sonobuoy label display toggle, the grid line display toggle, the level legend display toggle, the options control dialog, and the ability to export a bit map of the current display.

Sonobuoy identification labels are displayed slightly below and to the right of their sonobuoy symbol. Grid lines are drawn every five kiloyards starting from the origin (0, 0) at the centre of the display and working outward, and are labelled around the edges of the view pane. Whenever the map is being viewed at a scale that does not allow the entire 200 by 200 kiloyards area to fit in the TacPlot windowpane, the map viewing area can be scrolled using scroll bars. Individual sonobuoys may be selected on the TacPlot map view by left-clicking the symbols with a mouse. Double-clicking on a sonobuoy symbol will bring up the property sheet for that sonobuoy, allowing the user to edit that sonobuoy's properties. A deployment pattern may be selected by holding down the "Control" key and left-clicking on any sonobuoy within the pattern. Holding the "Control" key and double-clicking on a sonobuoy within a pattern will bring up the property sheet for that pattern.

When they are available, spatial probabilities are used to shade the map with colours representing different levels of probability. Two different types of spatial probabilities can be displayed, coverage and detection. The coverage probabilities represent the number of times the threat was at a given location over the number of times detection was possible (i.e. a ping occurred while it was there). The detection probabilities represent the number of times the threat was detected over the number of times the threat was there when detection was possible (i.e. a ping occurred while it was there). These displays can be presented by clicking on either **"TacPlot | Results | Coverage"** or **"TacPlot | Results | Detection"**, respectively. If the cursor is moved around the map the TacTool status bar (Section 5.0) displays the cursor's position on the map and the probability at that point.

If a simulation has been run and the results are available, the user may click on **"TacPlot | Results | Receiver Contact"** to display the map with receiver contact results. In this display the circle of each

receiver sonobuoy's symbol is coloured with the shade representing the contact ratio, the total number of contacts divided by the total number of Monte Carlo runs. When the cursor is moved over the map the cursor's position on the map is displayed in the TacTool status bar (Section 5.0). If the cursor moves over a receiver sonobuoy symbol's circle, the contact ratio for that sonobuoy, the total number of contacts, and the total number of runs in the Monte Carlo simulation are all written in the TacTool status bar.

The TacPlot map view has a context menu that can be accessed by right clicking anywhere in that view. The context menu is simply a floating version of the **"Deploy"** menu from the TacTool main menu with one added feature. When a deployment is added using the context menu, the kingpin's position is set to the cursor's position when the menu was invoked. This feature, combined with the map co-ordinate display on the TacTool status bar (Section 5.0), allows the user to quickly and easily place deployments on the map in a highly visual manner.

## 3.2 Deployment Tree View

The pane on the left-hand side of the TacPlot simulation window is the deployment tree view. This view lists all of the current deployments. If a deployment is composed of two or more sonobuoys, it will have a [+] symbol to the left of its name in the list. This indicates that the deployment can be further expanded by clicking on the [+] symbol to show the list of sonobuoys that compose it. When a deployment has been expanded the symbol to the left of its name will change to the [-] symbol. Clicking on the new symbol will collapse the list again and make the symbol revert to [+].

A deployment, or sonobuoy, can be selected by clicking on it in the list. The current selection will appear in red on the TacPlot map view (Section 3.1). Once selected, the sonobuoy can be deleted by pressing the "Delete" key, or edited either by pressing the "Enter" key or double clicking on the symbol. When a deployment or sonobuoy is deleted or edited, the deployment map is immediately updated to reflect the change. Initialising editing causes the appropriate "Deploy" property sheet dialog to be invoked, which is described in detail in Section 6.1 of this guide.

Under the Deployment Tree view is an area available for deployment annotations. Text may be entered and edited within this area in the same manner as with a simple editor such as Notepad, save that the contents cannot be saved to a separate file.

## 3.3 SimPlot Graph View

The SimPlot window contains the SimPlot graph view. The graph is used to display the temporal results of a simulation run. It is only meaningful if there are temporal data available from a simulation run; otherwise the message "NO DATA AVAILABLE" is displayed in the centre of the graph's viewing area.

When data are available, the viewing area contains a two dimensional graph of probability of first detection versus elapsed time from the start of the simulation. Both instantaneous and cumulative plots can be displayed. The instantaneous probabilities are calculated as the number of detections at a given time step divided by the total number of simulation runs. Cumulative probabilities are calculated as the cumulative sum of detections (from the first time step to a given time step) divided by the total number of simulation runs.

The choice of results to display can be selected from the **"SimPlot | PD Results"** submenu. This submenu can also be accessed as a context menu by clicking the right mouse button anywhere in the SimPlot window. The axis ranges displayed can be adjusted by clicking **"SimPlot | Options"** and entering the desired values in the property sheet dialog box (Section 6.7). This dialog box can also be accessed by double clicking the left mouse button anywhere in the SimPlot window.

## 4.0 TacTool Toolbar

The TacTool toolbar initially appears beneath the TacTool main menu. It can be moved to just about anywhere in the application window by clicking on it and dragging it with the mouse. Its purpose is to allow quick, one click access to commonly used menu items. These items currently include creating, opening, saving, and printing simulation files. Display of the toolbar can be toggled from the "View" menu.

## 5.0 TacTool Status Bar

The TacTool status bar appears along the bottom of the application window. It is used to display status information and is divided into five sections. Starting from the left-hand side, the first and largest section is used for status text display, providing information about menu options and command buttons in the form of short textual descriptions. The second section (first inset section) is the co-ordinate display. It shows the current location of the cursor on the TacPlot or SimPlot as an (x,y) co-ordinate pair in kiloyards or minutes. In addition, if there are results available the TacPlot co-ordinates are supplemented by results for that location related to the current display. See Section 3.1 for the actual contents of this section of the status bar. The remaining three sections are simple indicators for the current state of the "Caps Lock", "Number Lock", and "Scroll Lock" keys. Display of the status bar can be toggled from the "View" menu.

## 6.0 TacTool Dialogs

The TacTool application uses dialog boxes to accomplish much of its interaction with the user. Most of the user-provided modelling parameters and data are entered into property sheet dialogs. Property sheet dialogs are dialogs with multiple tabbed pages containing related information. The user can switch between pages by clicking on the tab of the desired page. Standard system file selection dialogs are used for choosing files to load or save. The following sections describe the various dialogs used in the TacTool application.

### 6.1 Sonobuoy Deployment Patterns

The deployment dialogs are used to edit the properties of deployment patterns (i.e. chevrons, containment circles, and distributed fields). With the exception of single sonobuoy deployments, which are covered in the next section, the deployment dialogs are essentially all the same. They are all property sheet dialogs composed of three pages. The first and second pages are identical for all patterns, while the third contains the parameters specific to the type of deployment pattern.

The first page is the "Kingpin" page. It allows the user to enter the position (x and y co-ordinates in kiloyards) of the pattern's kingpin buoy. The second page is the "Defaults" page, which allows the user to set the default sonobuoy parameters for the pattern. These parameters include the type, depth setting, lifetime, and activation time of the sonobuoys. The type is chosen from the list of defined sonobuoy types and the depth is then chosen from the list of available depths for the selected sonobuoy type. The lifetime is the time in minutes that the sonobuoy should remain active after it has been activated, and the activation time is the time in minutes after the start of the simulation that the sonobuoy should become active.

The third page comes in three varieties, one for each of the standard pattern types. It is therefore called the "Chevron" page for chevron deployments, the "Containment Circle" page for containment circle deployments, and the "Distributed Field" page for distributed field deployments.

The "Chevron" page allows the user to edit the chevron pattern-specification parameters. Figure 1 presents a graphical depiction of the chevron pattern and its parameters. These parameters include the apex bearing ($\beta$) with respect to True north, the apex angle (the angle between the two wings of the chevron, $\theta$), the spacing between sonobuoys ($\delta$, in kiloyards), and the number of sonobuoys to use in the pattern. A diagram of the angular relationships is included in the dialog box for clarification.

The "Containment Circle" page allows the user to edit the containment-circle pattern-specification parameters. Figure 2 presents a graphical depiction of the containment circle pattern and its parameters. These parameters include: the bearing ($\beta$), with respect to True north, where the first circle sonobuoy will be placed; the circle radius (r, in kiloyards); the spacing between sonobuoys ($\delta$, in kiloyards); the number of sonobuoys in the circle; and a flag to indicate whether or not a sonobuoy is to be placed in the kingpin position (i.e. the centre of the circle). Either the number of sonobuoys or the spacing between sonobuoys can be omitted (i.e. set to zero) and the omitted parameter will be calculated by the program to complete the circle pattern. If both parameters are supplied, then both are used.

The "Distributed Field" page allows the user to edit the distributed field pattern-specification parameters. Figure 3 presents a graphical depiction of the distributed field pattern and its parameters. These parameters include: the road bearing ($\beta$), with respect to True north; the walk angle ($\omega$) between the walk and road bearings; the spacing between sonobuoys on the road (r, in kiloyards); the spacing between walks (w, in

kiloyards); the number of sonobuoys along the first road; the number of walks; the extra buoy mode; and the layout mode. In Figure 3, β has been set to about 80° and ω to about -80°. There are three possible "extra buoy mode" settings: one less buoy in every second road, same number of buoys in all roads, and one more buoy in every second road. Figure 3 shows a pattern with the "extra buoy mode" set to be the same number of buoys in all roads. The layout mode can be set to one of three possible modes: Cartesian, isosceles, or equilateral. The layout mode is set to Cartesian in Figure 3. If the layout mode is set to equilateral then the spacing between walks is disabled and the spacing between sonobuoys on the road is used for both. If the layout mode is set to either equilateral or isosceles then sonobuoys in successive roads will be offset to be halfway between the sonobuoys of the previous road. In Cartesian mode the spacing between walks is as specified along the walk angle. The number of buoys for "even walks" may also be specified on this dialog. The possible values are one less buoy than the "odd walks", one more buoy than the "odd walks", or the same number of buoys as the "odd walks".

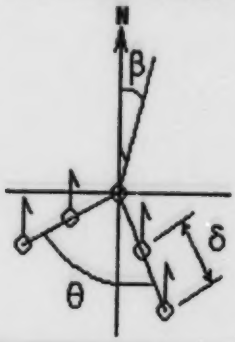


**Figure 1.**
**Chevron Pattern**

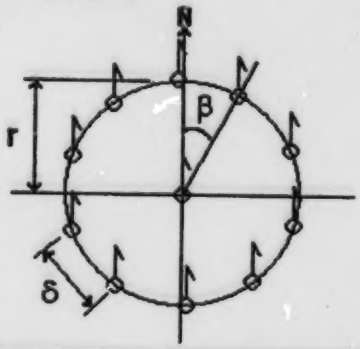


**Figure 2.**
**Containment Circle Pattern**

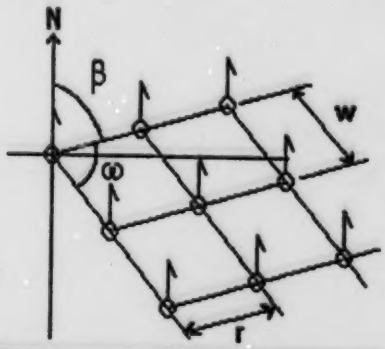


**Figure 3.**
**Distributed Field Pattern**

## 6.2 Sonobuoys

The same dialog is used for editing both single sonobuoy deployments and sonobuoys that are a member of a pattern. In both cases, a property sheet dialog that contains only a single page is used. This single page is a simply a combination of the first and second pages of the deployment pattern property sheet dialog. The only real difference is that this dialog refers to only one sonobuoy rather than a collection of sonobuoys.

## 6.3 Threat Type Specification

The "Simulation | Threat Type | Edit..." dialog box "Threat Type Properties" has two pages: "General" and "Target Strength".

The "General" page contains spaces for the threat's name, minimum and maximum speeds for a number of speed categories, and depths for a number of depth categories.

The "Target Strength" page allows the user to choose the numbers of bistatic aspect and angle sectors, and then assign target strengths for each combination of them.

## 6.4 Threat Profile Specification

The "Simulation | Threat Profile | Edit..." dialog box "Threat Operating Profile" has five pages: "General", "Position", "Initial Course", "Depth", and "Speed".

The "General" page allows the user to name the threat profile and allow tactic modification. Threat tactics fall into two general types; normal and reactive. Normal tactics are those that the threat carries out whether or not sonobuoy transmitters are detected. Reactive tactics are those that the threat carries out when sonobuoy transmitter signals of certain strength are detectable. Normal tactics must be specified for the threat profile for a simulation to run properly. Reactive tactics may be specified, but are not necessary for the running of the simulation.

The "Position" page has two sections. The first is the "Initial Position" portion, which allows the user to select initial position boundaries for a simulation run and a distribution method for these positions. Three initial position distribution methods exist; uniform rectangle, uniform polygon, and bivariate normal. If a uniform distribution is selected, then the minimum and maximum, x and y coordinate values must be specified in kiloyards. If a uniform polygon distribution is selected, the vertices defining the polygon must be entered, in order, in the entry box to the right of the dialog box. If a bivariate normal distribution is selected, then the x and y, mean and $3\sigma$ error values must be specified in kiloyards. The second section describes the operating area, with parameters depending on the shape of the area. A rectangular area requires minimum and maximum x and y values; a polygonal area requires the co-ordinates of the area's vertices, in order, defined in the entry box to the right of the operating area section; and a circular area requires the location of the circle's centre and a radius. When an operating area type is selected, default values are defined for the operating area parameters. These defaults define the boundary area of the defined initial position. All positions and distances are in kiloyards.

The "Initial Course" page has two sections: one for initial course and one for course change probabilities. If the initial course distribution is uniform then the threat's initial course will have an equal chance of being any bearing between 0 and 360 degrees, and no other values need be specified. If a normal distribution is selected, then the mean course and $3\sigma$ course error must be specified in degrees. Course change probabilities allow mean time between course changes for both normal tactics, and reactive tactics, which may be defined to specify what the threat may do when a signal of the specified reactive strength is detectable. It also allows the user to select a course change method: uniform random (any angle); a user-specified mean line of advance with a user-specified error; or normal about the current course with a user-specified error.

The "Depth" page two sections: one contains the initial depth probabilities for the four depth categories, and the other contains tactic probabilities for the depths and the duration spent at each. Note that the initial depth probabilities must sum to exactly 1.0. The depth change probabilities may be specified for both normal and reactive tactics. The threat tactic may be selected through use of a drop down control. Note that the values specified in the probability matrix must sum across the columns to be exactly 1.0. As values are entered, the sum column will be updated to indicate the updated value.

The "Speed" page has two sections: one contains initial speed probabilities for six speed classes, and the other has speed change probabilities for a six-by-four speed/depth class matrix. Note that the initial speed probabilities must sum to exactly 1.0. The speed/depth probabilities may be specified for both normal and reactive tactics. The threat tactic may be selected through use of a drop down control. Note that the values specified in the probability matrix must sum across the columns to be exactly 1.0. As well, the mean time between speed changes between depths must be given.

Once the data have been entered they may be saved in a threat profile (.thp) file named by the user via the "Simulation | Threat Profile | Save..." dialog box .

## 6.5 Sonobuoy Type Specification

Clicking on "**Simulation | Sonobuoy Types**" calls the "Available Sonobuoy Types" dialog box, which allows the user to create, edit, or delete sonobuoy type definitions for use in simulation deployments. Files of sonobuoy type definitions may also be saved to or loaded from disk.

To create a new sonobuoy type the user clicks on the **New** button to invoke the "Sonobuoy Type" property sheet dialog, fills in the necessary parameters and closes the dialog with the **OK** button. If the new sonobuoy type has a unique name, it will then be displayed in the "Sonobuoy Types" listbox. Otherwise, the user will be requested to enter a unique name.

To edit an existing sonobuoy type, the user highlights the desired type from the listbox, then either double clicks it or clicks the **Edit** button. In either case, the "Sonobuoy Type" dialog is invoked on the selected sonobuoy type. The user can then make the desired edits to the sonobuoy type and close the dialog with the **OK** button to accept the changes. If the edited sonobuoy type has a unique name, it will then be displayed in "Sonobuoy Types" listbox. Otherwise, the user will be requested to enter a unique name.

To delete an existing sonobuoy type, the user selects the type to be deleted from the listbox by clicking on it and then clicks on the **Delete** button. The deleted type will no longer appear in the listbox.

If at least one sonobuoy type is defined, then the user can save the currently defined sonobuoy types to a sonobuoy types (.sbt) file by clicking the **Save** button and providing a filename.

The user can load previously saved sonobuoy type definitions by clicking the **Load** button and selecting the previously saved file. Once loaded, the sonobuoy type names will be displayed in the listbox. If a sonobuoy type in a file being loaded has a name that duplicates an existing type name, then a number is appended to the end of the name of the type being loaded to make it unique.

## 6.6 "Sonobuoy Type" Dialog

The "Sonobuoy Type" property dialog contains three pages: the "General Properties" page, the "Receiver Properties" page and the "Transmitter Properties" page. This dialog, which is accessed from the "Available Sonobuoy Types" dialog, allows the user to edit the modelling parameters of sonobuoy types.

The "General Properties" page allows the user to provide a name for a sonobuoy type. It also allows the user to add and remove depth settings available to the sonobuoy type. New depth settings are added by entering a label and a depth value in the appropriate text boxes and clicking the **Add** button. The new setting will appear in the listbox. The user can delete an existing depth setting by clicking on it to select it and then clicking the **Remove** button. The setting will disappear from the listbox. The depth setting influences which environmental files are used in the simulation.

The "Receiver Properties" page allows the user to edit the properties of the sonobuoy type's receiver. There are three basic receiver properties in the current model: the bandwidth, the directivity index, and self-noise. Self-noise levels must be defined for the entire bandwidth of the receiver. In order to enforce this, the bandwidth is displayed as read only and is simply the total range for which self-noise has been defined. The bandwidth is initially set from zero to zero Hertz, which models a sonobuoy type with no receiver. To increase the bandwidth the user must redefine these self-noise levels. The range and level can be changed by selecting the listbox entry, and then entering the new minimum and maximum frequency values and the self-noise level into the appropriate text boxes above the listbox. Once the values have been entered click on the **Change** button to apply the new values to the listbox entry. To add additional self noise levels the

user must select an existing entry in the listbox and click the **Split** button to partition the frequency range into two equal parts. The two ranges can then be modified to the desired values. The user can remove a self-noise level by selecting the entry and clicking the **Join** button. The entry will be joined with the entry following it in the listbox. At this point in the model development a single value of directivity index is used for the entire band and passive recognition differential is assumed to be zero.

The "Transmitter Properties" page allows the user to edit the properties of the sonobuoy type's transmitter. There are seven basic transmitter properties in the current model: centre frequency and type, bandwidth, source level, pulse length, reverberation model, and active detection threshold. The centre frequency is the centre frequency of the transmitted signal in Hertz. The type is the type of signal transmitted (i.e. explosive, CW, or FM). The bandwidth is the total bandwidth in Hertz, and a bandwidth of zero Hertz models a sonobuoy type with no transmitter. The source level is measured as decibels reference 1 $\mu Pa^2/Hz$ at 1 yd. Pulse length is measured in microseconds, and detection threshold is in decibels of signal power in the receive bandwidth to noise in a 1 Hz band for a 50% probability of detection and stated probability of false alarm. The reverberation model is selected from the list of models available in the currently loaded environment.

## 6.7 TacPlot Options

The "**TacPlot | Options**" dialog box "TacPlot Options" contains three pages: "Detection Colour Levels", "Coverage Colour Levels", and "Receiver Contact Colour Levels". The pages are essentially the same in that they control the colour levels for the various simulation run TacPlot output plots. These pages allow the user to modify the mapping of levels of probability (for detection and coverage) or contact ratio (for receiver contact) to colour in the display of results on the TacPlot. The user does this by setting the maximum and minimum levels of probability or contact ratio and selecting either a logarithmic or a linear scale. This information is then used to map the probabilities or contact ratios to the sixteen different colour values comprising the colour scale. A linear scale should usually be used to view TacPlot detection probability results while the logarithmic scale should be used for viewing threat location coverage and receiver contact.

## 6.8 SimPlot Options

The "**SimPlot | Options**" dialog box "SimPlot Options" contains only one page, the "Axis Ranges" page. This page allows the user to set the minimum and maximum times and probabilities to be displayed on the SimPlot. The time range is limited to be between zero and the maximum time on station for the simulation run. Probability axis values are limited to the range of zero to one, with a minimum difference of 0.1 between the minimum and maximum probabilities.

## 6.9 Ping Schedule

The "**Simulation | Ping Schedule**" dialog box "Ping Schedule" allows the user to schedule ping transmissions for any and all sonobuoys in the simulation that have a transmit capability. If an attempt is made to invoke this dialog when there are no sonobuoys with transmitters deployed, the dialog will not open. Instead, a message box will be displayed to inform the user that no transmitters are available for scheduling.

Once the dialog is open, pings can be scheduled. This is done by entering a time in the "Time (minutes)" edit box, selecting a transmitter from the "Transmitter" drop list box, and finally clicking the **Add** button. When a ping has been scheduled it will appear in the time ordered list of pings below the "Time (minutes)" and "Transmitter" boxes. To remove a ping from the schedule, simply select it and click the **Remove** button. The selected transmitter and time will disappear from the ping schedule.

A scheduled ping may be modified by: selecting it in the scheduled ping list; entering modified values in the "Time (minutes)" and "Transmitter" boxes; and clicking the **Modify** button. As well, a selected ping may be shifted in time by entering a shift value in minutes in the "Shift (minutes)" edit box and clicking the **Shift** button. A selected ping may be used as the basis of a new ping by entering a value in the "Shift (minutes)" edit box and clicking the **Copy Shift** button. The new ping will be placed in the appropriate position in the time-ordered ping list and selected.

A number of pings may be generated at a time by entering values in both the "Shift (minutes)" and "Pings to Add" edit boxes, and clicking the **Generate** button. The basis for the generation will be the first currently selected scheduled ping or, if none is currently selected, the values of the Time and Transmitter fields.

Pings may be selected one at a time from the scheduled ping list by left-clicking on individual pings. As well, multiple pings may be selected by holding down the "Shift" or the "Control" keys when left-clicking pings. Holding down the "Shift" key will cause all pings in the list between the last selected and the clicked ping to be selected. Holding down the "Control" key will cause the selection of both the last selected ping and the clicked ping, without selecting those between the two.

When the user is finished editing the ping schedule, he can either click the **OK** button to accept all of the changes, or click the **Cancel** button to discard the changes. Cancelling will return the schedule to the state it was in before the dialog was invoked.

The user may also import or export transmitters and associated ping schedule from or to a transmitter (*.xmt) file.

## 6.10 Simulation Options

The "**Simulation | Options**" dialog box "Simulation Options" contains five pages: "Run Parameters", "Transition Curve Parameters", "Active End Conditions", "Passive End Conditions", and "General End Conditions". This dialog box allows the user to set the control parameters for the simulation run.

The "Run Parameters" page allows the user to set the number of times the simulation will run for the purposes of gathering statistics. It also allows the user to control the level of detail in the results by setting the time step size in minutes and the detection cell size in kiloyards. Adequate fidelity in the Simplot window can be obtained from conducting on the order of 1000 runs. However, TacPlot results typically require at least 20 runs for every possible submarine initial position. For example, a scenario using 1 kiloyard by 1 kiloyard spatial detection cells and a 20 kiloyard by 20 kiloyard initial position area will require a minimum of 20*20*20 = 8000 runs to obtain reasonable Tacplot results. Increasing the number of runs will improve the fidelity of results.

The "Transition Curve Parameters" page allows the user to set the sigma values for the active and passive transition curves used in the simulation. Log normal transition curves are assumed and the values are in decibels.

The "Active End Conditions" page allows the user to select the number of active detections that must occur in a single time step in order for a detection to be recorded.

The "Passive End Conditions" page allows the user to select the number of passive detections that must occur in a single time step in order for a detection to be recorded. However, passive detections are not currently implemented in TacTool.

The "General End Conditions" page allows the user to set the maximum amount of time in minutes that a single simulation run will continue to look for detections.

# 7.0 TacTool File Formats

One input file must be created by with a text editor outside of the TacTool application in order to run a simulation in TacTool, the environment (.env) file. This file describes the details of the simulation's acoustic environment. Section 7.1 provides the details of the file format and presents a sample environment file.

Section 7.2 provides the format of the simulation (.sts) file which is created by TacTool to save a simulation scenario and results. This file is created by TacTool to save the current settings and results, and is read in at the start of a TacTool run to allow the user to continue operations where they were left off.

The following conventions have been used in the file format specifications:

- <BOF> represents the beginning of the file.
- <EOF> represents the end of the file.
- "Line: " is used to indicate the beginning of the specification of a single line of file content.
- Text enclosed between "<" and ">" is used to represent variable file values.
- "[i]" is used to indicate a data array index.
- Literal strings, which must appear in the file exactly as shown, are enclosed in quotation marks (" ").
- Statements such as "for i = 1 to <some number>" are used to indicate multiple iterations of the enclosed specification.
- Statements such as "Line: <data array>[for i = 1 to <some number>]" are used to indicate multiple data array elements on a single file line.

## 7.1 Environment File Format

An environment (*.env) file contains the data and datafile links for ambient noise, transmission loss, and monostatic and bistatic reverberation loss. It also contains the source, receiver, and threat depths for which these data are defined. This section is devoted to describing the format of the environment file. Following the description is a sample environment file. A user creating or editing an environment file must be extremely careful to follow the format since errors in the format may, depending on their type and location, cause highly unpredictable actions from TacTool.

Three types of files are linked to an environment file. They are transmission loss, monostatic reverberation loss, and bistatic reverberation loss files. These file types all share the same basic format:

Line: "CURVE"
Line: <x value> <y value>

The second line is repeated for each data point in the curve. Successive x values must monotonically increase by a regular increment value. In reality, the "CURVE" statement does not have to be on the first line in the file but can be preceded by any amount of text, all of which will be ignored. Text following the curve data points will be ignored as well, so long as there is a distinct end to the curve data values (e.g. a blank line or a line without numeric characters). Note that the data points will also be terminated if the x values cease to increase monotonically. The actual x values are ignored in favour of the step value specified in the environment file (i.e. <range step> for transmission loss files and <time step> for reverberation loss files). The <number of lines to skip> value can be used as an alternative to the "CURVE" token in a data file. When this value is not zero, the data are assumed to start on the line number specified. The <number of samples to skip> value can be used to subsample curve data. It causes the

specified number of samples to be skipped between recorded samples. Note that this must be accounted for in the *.env file step size.

There is one transmission loss file for each frequency and buoy-threat depth pair combination. The curve data for transmission loss should consist of distance and loss level pairs.

There is one monostatic reverberation-loss file for each frequency, source depth, and receiver depth combination. The curve data for monostatic reverberation loss should consist of time and loss level pairs.

There is one bistatic reverberation-loss file for each frequency, source depth, receiver depth, and separation distance combination. The curve data for bistatic reverberation loss should consist of time and loss level pairs.

Environment file format specification:

<BOF>
Line: comment line
Line: <number of buoy depths> <number of threat depths> <number of source depths> <number of receiver depths> <number of frequencies>
Line: comment line
for i = 1 to <number of frequencies>
{
    Line: <representative frequency>[i] <minimum frequency>[i] <maximum frequency>[i] <ambient noise level>[i]
}
Line: comment line
for i = 1 to <number of buoy depths>
{
    Line: <buoy depth>[i]
}
Line: comment line
for i = 1 to <number of threat depths>
{
    Line: <threat depth>[i]
}
Line: comment line
for i = 1 to <number of source depths>
{
    Line: <source depth>[i]
}
Line: comment line
for i = 1 to <number of receiver depths>
{
    Line: <receiver depth>[i]
}
Line: comment line
Line: <number of lines to skip> <range step> <number of ranges to skip>
for i = 1 to <number of frequencies>
{
    for j = 1 to <number of buoy depths>
    {
        for k = 1 to <number of threat depths>

```
                {
                        Line:   <transmission loss filename>[i][j][k]
                }
        }
}
Line:   comment line
Line:   <number of source types>
for i = 1 to <number of source types>
{
        Line:   comment line
        Line:   <source name>[i]
        Line:   comment line
        Line:   <source frequency>[i] <source type>[i]
        Line:   comment line
        Line:   <number of lines to skip>[i] <time step>[i] <number of samples to skip>[i]
        Line:   comment line
        for j = 1 to <number of source depths>
        {
                Line:   <source depth>[j] <monostatic reverberation loss filename>[i][j]
        }
        Line:   comment line
        Line:   <number of bistatic separations>
        Line:   comment line
        for j = 1 to <number of source depths>
        {
                for k = 1 to <number of receiver depths>
                {
                        for l = 1 to <number of bistatic separations>
                        {
                                Line:   <source depth>[j] <receiver depth>[k] <bistatic
                                        separation>[l] <bistatic reverberation loss
                                        filename>[i][j][k][l]
                        }
                }
        }
}
<EOF>
```

Sample environment file:

All comment lines in the sample file begin with an exclamation mark in column 1. This is not required by TacTool but it makes these lines much easier to locate when a user wishes to examine the file and is highly recommended.

```
<BOF>
! buoyDepths thrtDepths srcDepths rcvDepths numFreqs
2 1 2 1 8
! (repFreq minFreq maxFreq) * numFreqs
7.5     5       10      83
50      10      100     73
150     100     200     70
```

```
300   200   500   68
800   500   1000  68
1200  1000  2500  62
3800  2500  6000  55
8500  6000  10000 50
! (buoyDepth) * buoyDepths
30
60
! (thrtDepth) * thrtDepths
30
! (srcDepth) * srcDepths
30
60
! (rcvDepth) * rcvDepths
60
! skipLines rangeStep rangeSkip
0 0.250 0
grand_win_11_30.s30_saf
grand_win_11_30.s30_saf
grand_win_50_30.s30_saf
grand_win_50_30.s30_saf
grand_win_150_30.s30_saf
grand_win_150_30.s30_saf
grand_win_300_30.s30_saf
grand_win_300_30.s30_saf
grand_win_800_30.s30_multip
grand_win_800_30.s30_multip
grand_win_12_30.s30_multip
grand_win_12_30.s30_multip
grand_win_38_30.s30_multip
grand_win_38_30.s30_multip
grand_win_85_30.s30_multip
grand_win_85_30.s30_multip
! srcTypes
2
! srcName
DICAST CW 1500 Hz
! srcFrequency srcType
1500 CW
! lineSkip timeStep sampleSkip
0 1 0
! (srcDepth monoFilename) * srcDepths
30 grand_win_lfdipc_30.rev_multip
60 grand_win_lfdipc_30.rev_multip
! bseps
7
! (srcDepth rcvDepth bsep biFilename) * srcDepths * rcvDepths * bseps
30 60  1 lfdipc_win_sh_b01km.rev
30 60  5 lfdipc_win_sh_b05km.rev
30 60 10 lfdipc_win_sh_b10km.rev
30 60 20 lfdipc_win_sh_b20km.rev
30 60 30 lfdipc_win_sh_b30km.rev
30 60 40 lfdipc_win_sh_b40km.rev
30 60 50 lfdipc_win_sh_b50km.rev
60 60  1 lfdipc_win_sh_b01km.rev
60 60  5 lfdipc_win_sh_b05km.rev
60 60 10 lfdipc_win_sh_b10km.rev
60 60 20 lfdipc_win_sh_b20km.rev
60 60 30 lfdipc_win_sh_b30km.rev
```

```
60 60 40 lfdipc_win_sh_b40km.rev
60 60 50 lfdipc_win_sh_b50km.rev
! srcName
DICAST FM 2800 Hz
! srcFrequency srcType
2800 FM
! lineSkip timeStep sampleSkip
0 1 0
! (srcDepth monoFilename) * srcDepths
30 grand_win_lfdipf_30.rev_multip
60 grand_win_lfdipf_30.rev_multip
! bseps
7
! (srcDepth rcvDepth bsep biFilename) * srcDepths * rcvDepths * bseps
30 60  1 lfdipf_win_sh_b01km.rev
30 60  5 lfdipf_win_sh_b05km.rev
30 60 10 lfdipf_win_sh_b10km.rev
30 60 20 lfdipf_win_sh_b20km.rev
30 60 30 lfdipf_win_sh_b30km.rev
30 60 40 lfdipf_win_sh_b40km.rev
30 60 50 lfdipf_win_sh_b50km.rev
60 60  1 lfdipf_win_sh_b01km.rev
60 60  5 lfdipf_win_sh_b05km.rev
60 60 10 lfdipf_win_sh_b10km.rev
60 60 20 lfdipf_win_sh_b20km.rev
60 60 30 lfdipf_win_sh_b30km.rev
60 60 40 lfdipf_win_sh_b40km.rev
60 60 50 lfdipf_win_sh_b50km.rev
! End of environment description
<EOF>
```

## 7.2 Simulation File Format

The simulation (*.sts) file is the main type of file created by the TacTool application. There is no reason that this file would have to be created in a text editor as it is generated by the TacTool application. However, its format is specified here because the simulation results are embedded in the file. Thus, to be able to use the results outside of the application the user must know how they are stored in the file. Note that external modification of simulation files is not recommended.

Simulation file format specification:

<BOF>
Line: "TacTool File v1.1"
Line: <number of scenario note lines>
for i = 1 to <number of scenario note lines>
{
    Line: <scenario note line>[i]
}
Line: <environment filename>
Line: "THREAT TYPE FILE v1.0"
Line: <threat type name>
Line: <speed categories' minima> i = 1 to 6
Line: <speed categories' maxima> i = 1 to 6

```
Line:   <depth categories' depths> i = 1 to 4
Line:   "0 Passive data go here."
Line:   <number of active data alpha angle sectors> <number of active data beta angle sectors>
for a = 1 to <number of alpha angle sectors>
{
        Line:   <target strength>[a][for b = 1 to <number of beta angle sectors>]
}
Line:   "THREAT PROFILE FILE v1.0"
Line:   <threat profile name>
Line:   <use normal tactics flag> < use reactive tactics flag> <reaction level> <reaction time>
Line:   <course code> <mean course direction> <mean course direction error>
for i = 1 to 2 (normal and reactive tactics)
{
        Line:   <mean time between course changes> <course change method code>
                <course mean line of advance direction>
                <course mean line of advance direction error>
                <error about the normal course change value>
}
Line:   <initial probability (P) of being at surface depth> <P of being at periscope depth>
        <P of being at medium depth> <P of being at deep depth>
for i = 1 to 2 (normal and reactive depth change probabilities)
{
        for j = 1 to 4 (surface, periscope, medium, and deep depth)
        {
                Line:   <probability of depth change>[i][j][for k = 1 to 4 (surface, periscope,
                        medium, and deep depth)] <mean time between depth changes>
        }
}
Line:   <initial probability (P) of being stopped> <P of being at quarter speed>
        <P of being at half speed> <P of being at cruising speed>
        <P of being at full speed> <P of being at flanking speed>
for i = 1 to 2 (normal and reactive depth change probabilities)
{
        for j = 1 to 4 (surface, periscope, medium, and deep depth)
        {
                Line:   <probability of depth change>[i][j][for k = 1 to 6 (6 speed classes)]
                        <mean time between speed changes>
        }
}
Line:   <initial area type code> <operating area type code>
Line:   <number of points on the initial area polygon>
for i = 1 to <number of points on the initial area polygon>
{
        Line:   <X position of the polygon's vertex> <Y position of the polygon's vertex>
}
Line:   <number of points on the operating area polygon>
for i = 1 to <number of points on the operating area polygon>
{
        Line:   <X position of the polygon's vertex> <Y position of the polygon's vertex>
}
Line:   <number of sonobuoy types>
for i = 1 to <number of sonobuoy types>
{
        Line:   <sonobuoy type name>
        Line:   <number of sonobuoy depths>
```

```
        for j = 1 to <number of sonobuoy depths>
        {
                Line:   <depth value> <depth label>
        }
        Line:   <receiver directivity index>
        Line:   <number of self noise partitions> <minimum frequency> <maximum frequency>
                <self noise level>[1]
        for j = 1 to <number of self noise partitions>
        {
                Line:   <self noise partition frequency>[j] <self noise level>[j+1]
        }
        Line:   <transmitter frequency> <transmitter bandwidth> <transmitter source level>
                <transmitter type>
        Line:   <transmitter pulse count> <transmitter pulse length>
                <transmitter detection threshold> <transmitter probability of false alarm>
        Line:   <transmitter reverberation model name>
}
Line:   <number of deployments>
for i = 1 to <number of deployments>
{
        Line:   <deployment type name>
        if <deployment type name> is "Chevron" then
        {
                Line:   <number of sonobuoys> <bearing> <apex angle>
                        <sonobuoy spacing>
        }
        if <deployment type name> is "Distributed Field" then
        {
                Line:   <number of sonobuoy in a road> <road bearing>
                        <distance between sonobuoys in a road>
                        <number of sonobuoys in a walk> <walk angle>
                        <distance between sonobuoys in a walk> <extra buoy mode>
                        <layout mode>
        }
        if <deployment type name> is "Containment Circle" then
        {
                Line:   <number of sonobuoys> <sonobuoy spacing> <bearing> <radius>
                        <kingpin flag>
        }
        Line:   <default x position> <default y position> <default depth> <default start time>
                <default lifetime> <default number of pings>
        Line:   <default sonobuoy type name>
        for j = 1 to <default number of pings>
        {
                Line:   <default ping time>[j]
        }
        Line:   <number of sonobuoys>
        for j = 1 to <number of sonobuoys>
        {
                Line:   <x position> <y position> <depth> <start time> <lifetime>
                        <default number of pings>
                Line:   <sonobuoy type name>
                for k = 1 to <default number of pings>
                {
                        Line:   <default ping time>[k]
```

```
                }
        }
}
Line:   "SIMULATION OPTIONS v1.1"
Line:   <number of runs> <detection cell size> <simulation time step>
        <maximum simulation time> <active sigma> <passive sigma>
        <number of active detections required> <number of timesteps with active detection>
        <number of passive detection required>
Line:   "SIMULATION RESULTS v1.0"
Line:   <simulation result's state>
if <simulation result's state> is 3 then
{
        Line:   <total number of runs> <total number out-of-bounds> <total number out-of-time>
                <total number visited>
        Line:   <area width> <area height> <detection cell size> <number of cells across>
                <number of cells down>
        Line:   <maximum simulation time> <simulation time step> <number of time cells>
        Line:   "SPATIAL RESULTS v1.0"
        Line:   <minimum detection probability> <maximum detection probability>
                <minimum coverage probability> <maximum coverage probability>
        for i = 1 to <number of cells down>
        {
                Line:   <number of detections>[i][for j = 1 to <number of cells across>]
        }
        Line:   blank line
        for i = 1 to <number of cells down>
        {
                Line:   <number of visits>[i][for j = 1 to <number of cells across>]
        }
        Line:   "TEMPORAL RESULTS v1.0"
        for i = 1 to <number of time cells>
        {
                Line:   <number of detections>[i]
        }
        Line:   blank line
        for i = 1 to <number of time cells>
        {
                Line:   <number of visits>[i]
        }
}
<EOF>
```

## 7.3 Threat Type File Format

The threat type (*.tht) file defines the type of threat used in a TacTool simulation. There is no reason that this file would have to be created in a text editor as it is generated by the TacTool application. The format of the file is presented here as an aid to debugging simulation runs; a knowledgeable user may be able to determine possible reasons for unexpected simulation results by reviewing the contents of this file. Note that external modification of threat type files is not recommended.

Threat Type file format specification:

```
<BOF>
Line:   "THREAT TYPE FILE v1.0"
```

```
Line:   <threat type name>
Line:   <speed categories' minima> i = 1 to 6
Line:   <speed categories' maxima> i = 1 to 6
Line:   <depth categories' depths> i = 1 to 4
Line:   "0 Passive data go here."
Line:   <number of active data alpha angle sectors> <number of active data beta angle sectors>
for a = 1 to <number of alpha angle sectors>
{
        Line:   <target strength>[a][for b = 1 to <number of beta angle sectors>]
}

<EOF>
```

## 7.4 Threat Profile File Format

The threat profile (*.tht) file defines the profile of the threat used in a TacTool simulation. That is, this file defines the initial position, operating area, course, depth, and speed probabilities involved in the threat actions during a simulation run. Tactics for both normal and reactive threat actions are defined within the file. There is no reason that this file would have to be created in a text editor as it is generated by the TacTool application. The format of the file is presented here as an aid to debugging simulation runs; a knowledgeable user may be able to determine possible reasons for unexpected simulation results by reviewing the contents of this file. Note that external modification of threat type files is not recommended.

Threat profile file format specification:

```
<BOF>
Line:   "THREAT PROFILE FILE v1.0"
Line:   <threat profile name>
Line:   <use normal tactics flag> < use reactive tactics flag> <reaction level> <reaction time>
Line:   <course code> <mean course direction> <mean course direction error>
for i = 1 to 2 (normal and reactive tactics)
{
        Line:   <mean time between course changes> <course change method code>
                <course mean line of advance direction>
                <course mean line of advance direction error>
                <error about the normal course change value>
}
Line:   <initial probability (P) of being at surface depth> <P of being at periscope depth>
        <P of being at medium depth> <P of being at deep depth>
for i = 1 to 2 (normal and reactive depth change probabilities)
{
        for j = 1 to 4 (surface, periscope, medium, and deep depth)
        {
                Line:   <probability of depth change>[i][j][for k = 1 to 4 (surface, periscope,
                        medium, and deep depth)] <mean time between depth changes>
        }
}
Line:   <initial probability (P) of being stopped> <P of being at quarter speed>
        <P of being at half speed> <P of being at cruising speed>
        <P of being at full speed> <P of being at flanking speed>
for i = 1 to 2 (normal and reactive depth change probabilities)
{
```

```
        for j = 1 to 4 (surface, periscope, medium, and deep depth)
        {
                Line:   <probability of depth change>[i][j][for k = 1 to 6 (6 speed classes)]
                        <mean time between speed changes>
        }
}
Line:   <initial area type code> <operating area type code>
Line:   <number of points on the initial area polygon>
for i = 1 to <number of points on the initial area polygon>
{
        Line:   <X position of the polygon's vertex> <Y position of the polygon's vertex>
}
Line:   <number of points on the operating area polygon>
for i = 1 to <number of points on the operating area polygon>
{
        Line:   <X position of the polygon's vertex> <Y position of the polygon's vertex>
}

<EOF>
```

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The TacTool sonobuoy tactical development tool has been developed to assist tactical development officers to plan and work with multistatic sonobuoy scenarios. The tool allows the specification of multistatic sonobuoy patterns and the analysis of the pattern detection performance in terms of coverage and cumulative probability of detection. The tool uses a Monte Carlo simulation engine to calculate performance measures. This document provides the user with a guide to the TacTool version 2.1's features, and the format of certain critical input files.

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